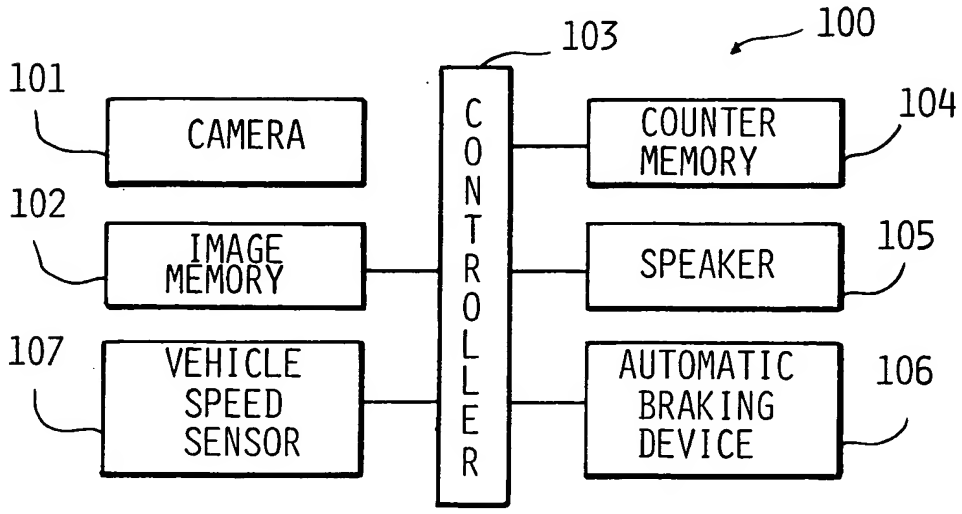


FIG. 1

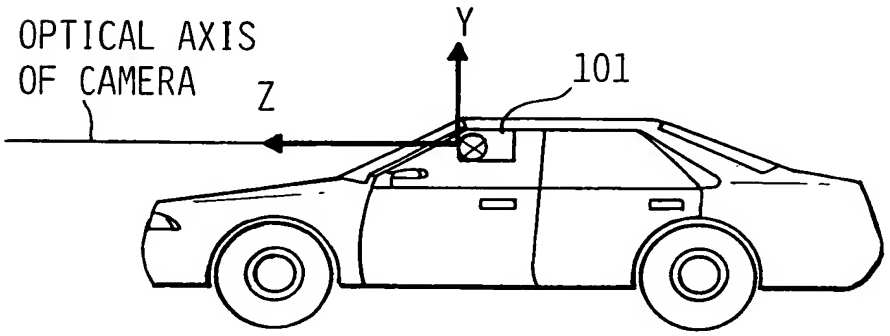


FIG 2A

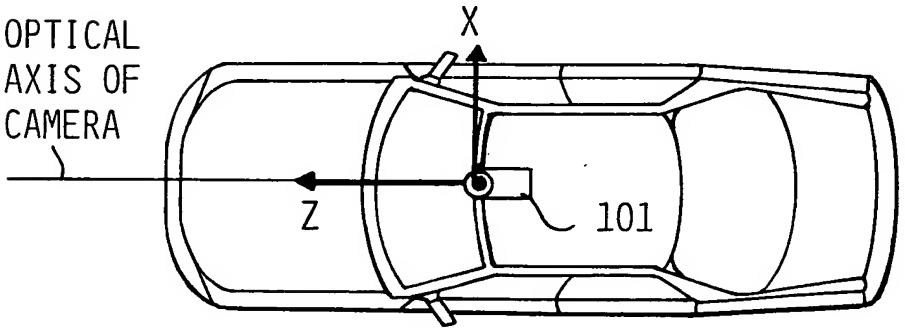


FIG 2B

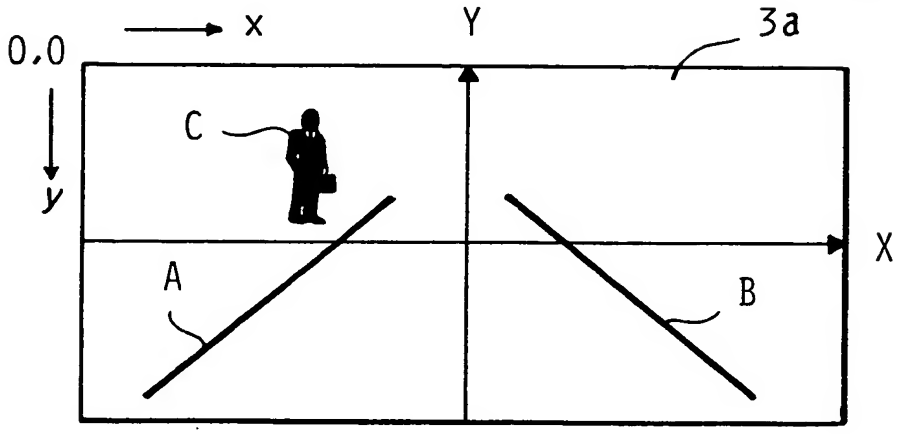


FIG. 3

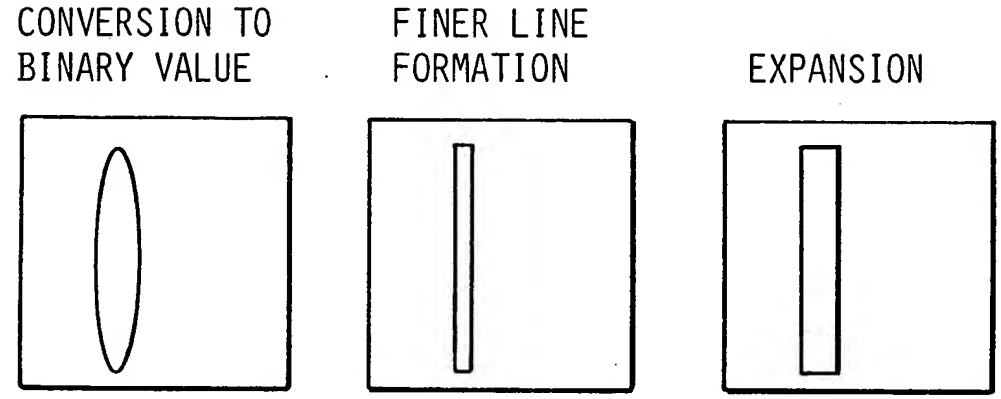


FIG. 4A FIG. 4B FIG. 4C

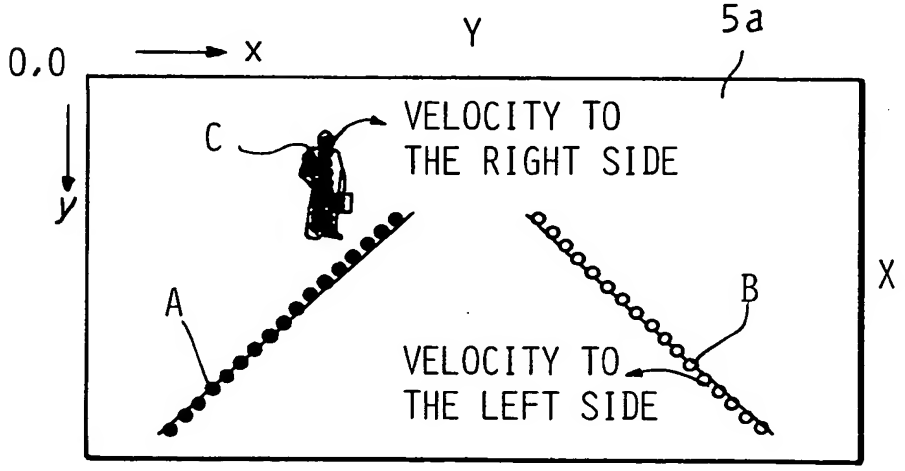


FIG. 5

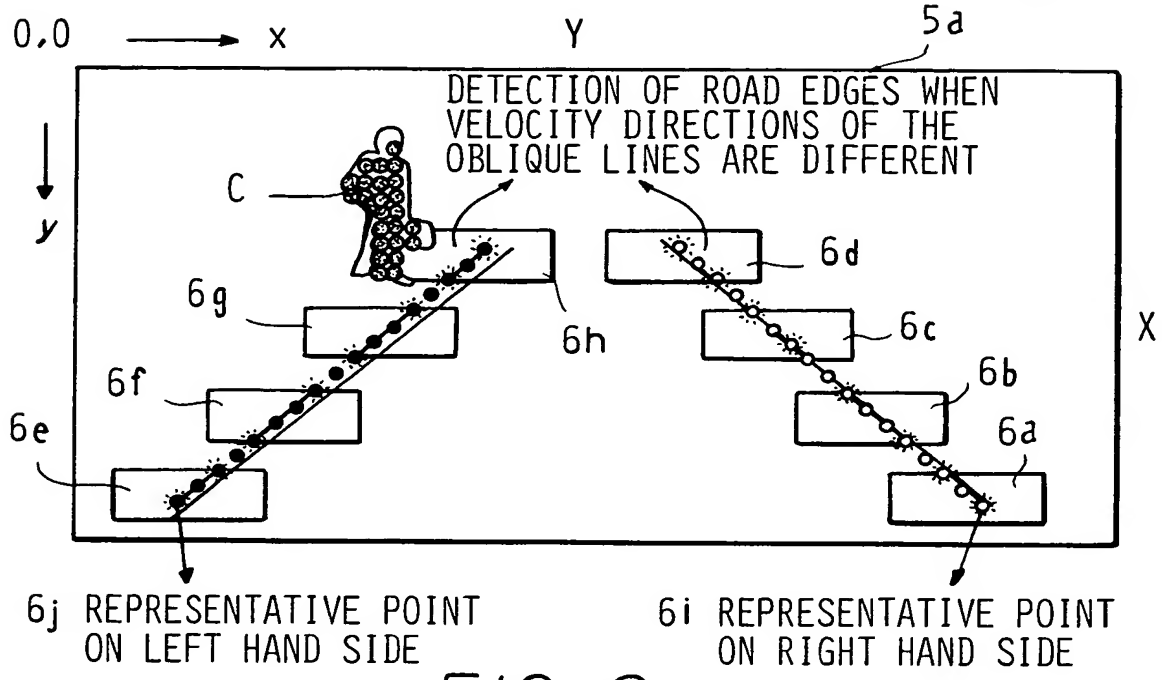


FIG. 6

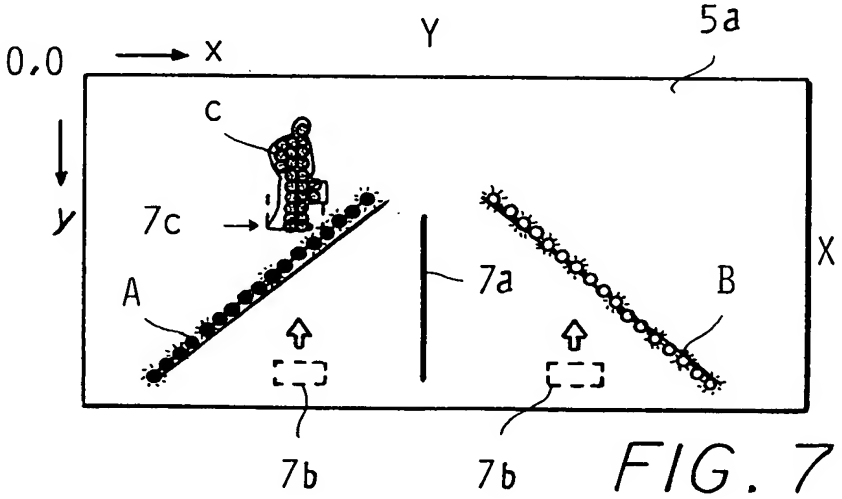


FIG. 7

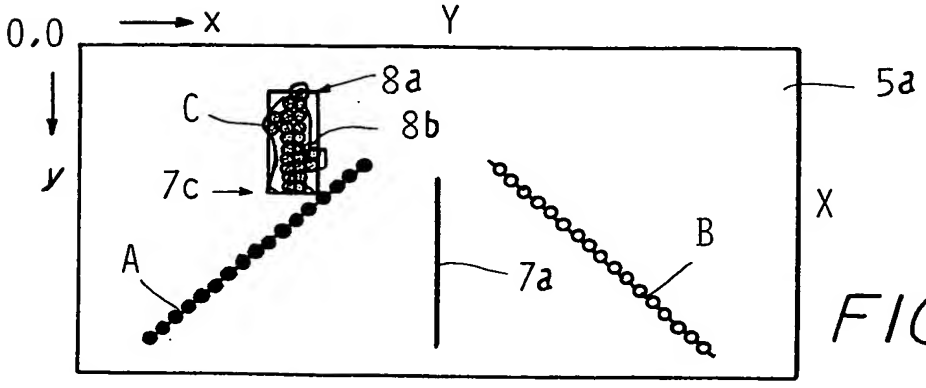


FIG. 8

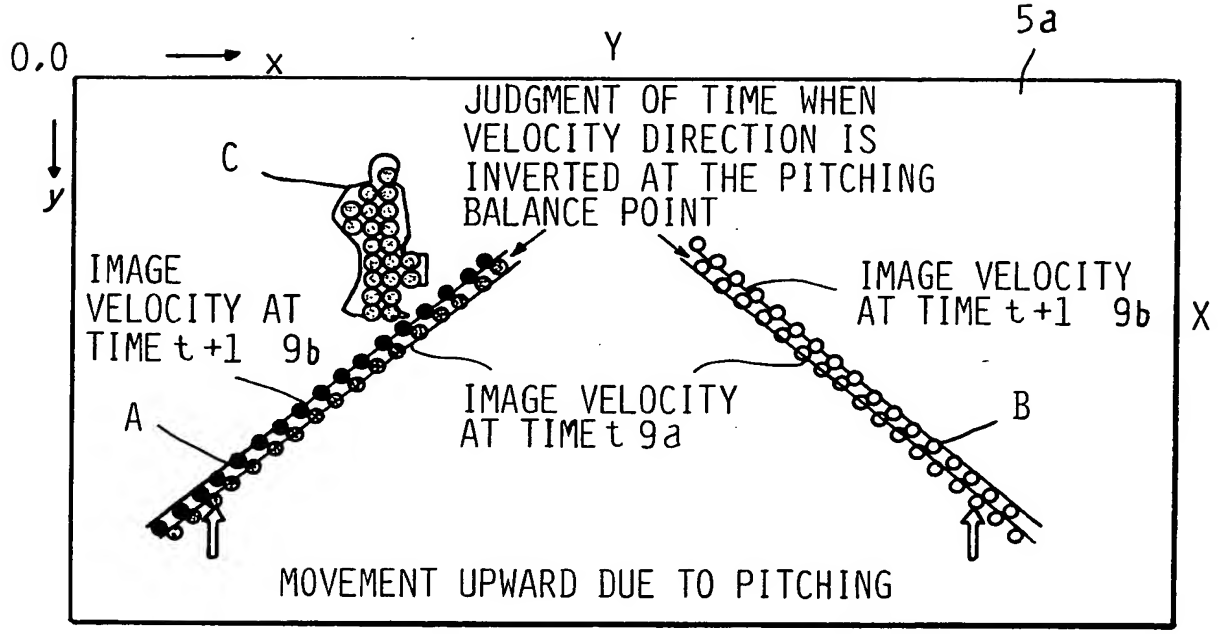

0.0
x
Y
5a
JUDGMENT OF TIME WHEN VELOCITY DIRECTION IS INVERTED AT THE PITCHING BALANCE POINT
C
y
IMAGE VELOCITY AT TIME t+1 9b
IMAGE VELOCITY AT TIME t+1 9b
X
IMAGE VELOCITY AT TIME t 9a
A
B
MOVEMENT UPWARD DUE TO PITCHING

FIG. 9

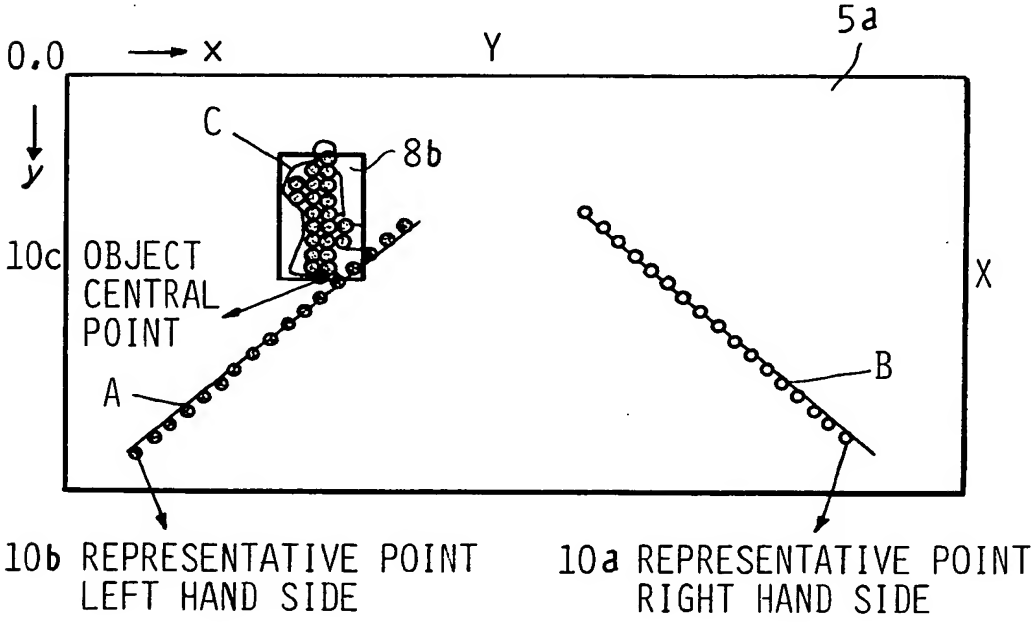

0.0
x
Y
5a
C
8b
y
10c OBJECT CENTRAL POINT
X
A
B
10b REPRESENTATIVE POINT LEFT HAND SIDE
10a REPRESENTATIVE POINT RIGHT HAND SIDE

FIG. 10

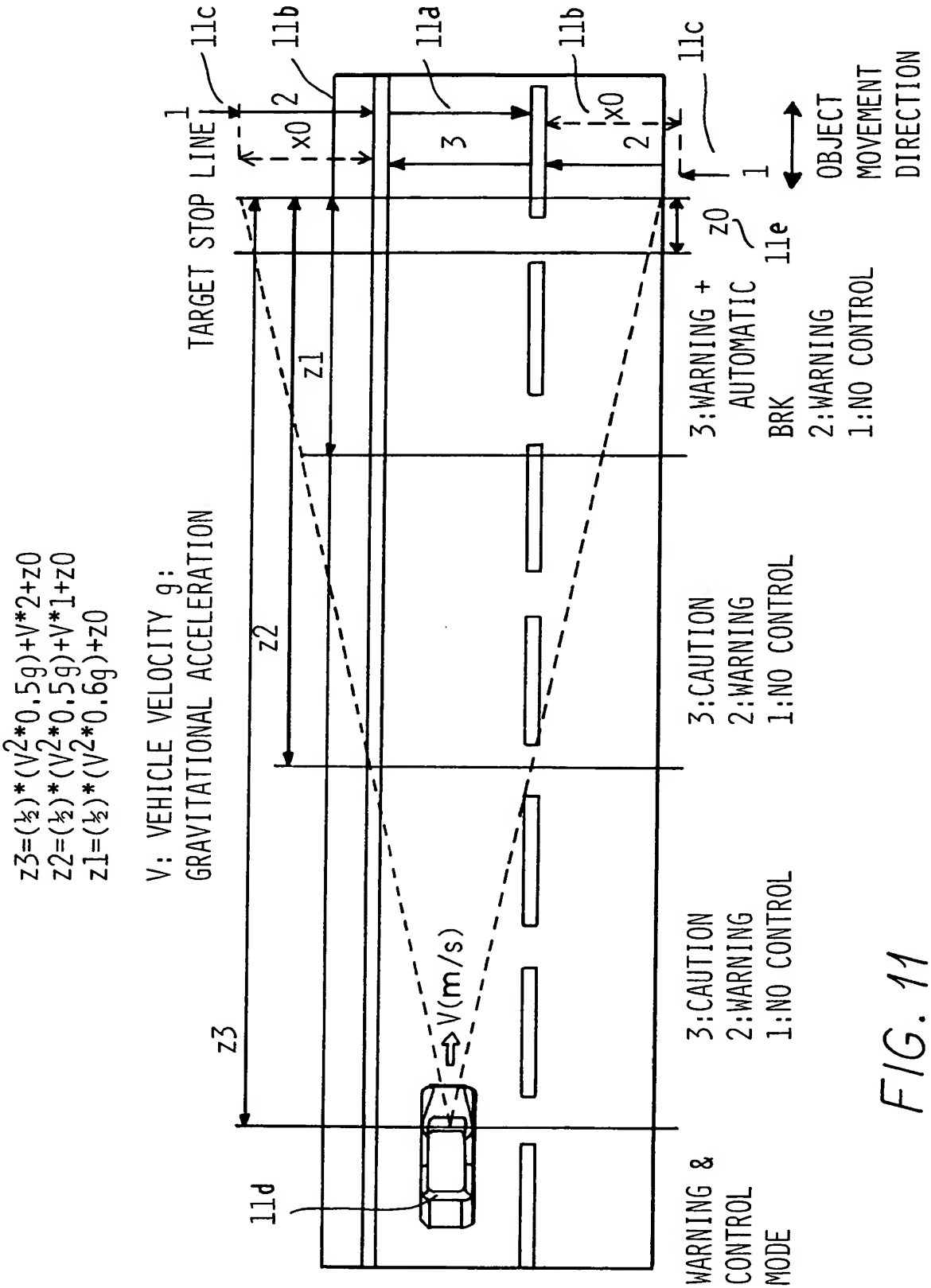

z3=(½)*(V2*0.5g)+V*2+z0
z2=(½)*(V2*0.5g)+V*1+z0
z1=(½)*(V2*0.6g)+z0
V: VEHICLE VELOCITY g: GRAVITATIONAL ACCELERATION
TARGET STOP LINE
11c
11b
11a
11b
11c
11d
11e
x0
x0
z0
z1
z2
z3
V(m/s)
OBJECT MOVEMENT DIRECTION
3:WARNING + AUTOMATIC BRK
2:WARNING
1:NO CONTROL
3:CAUTION
2:WARNING
1:NO CONTROL
3:CAUTION
2:WARNING
1:NO CONTROL
WARNING & CONTROL MODE

FIG. 11

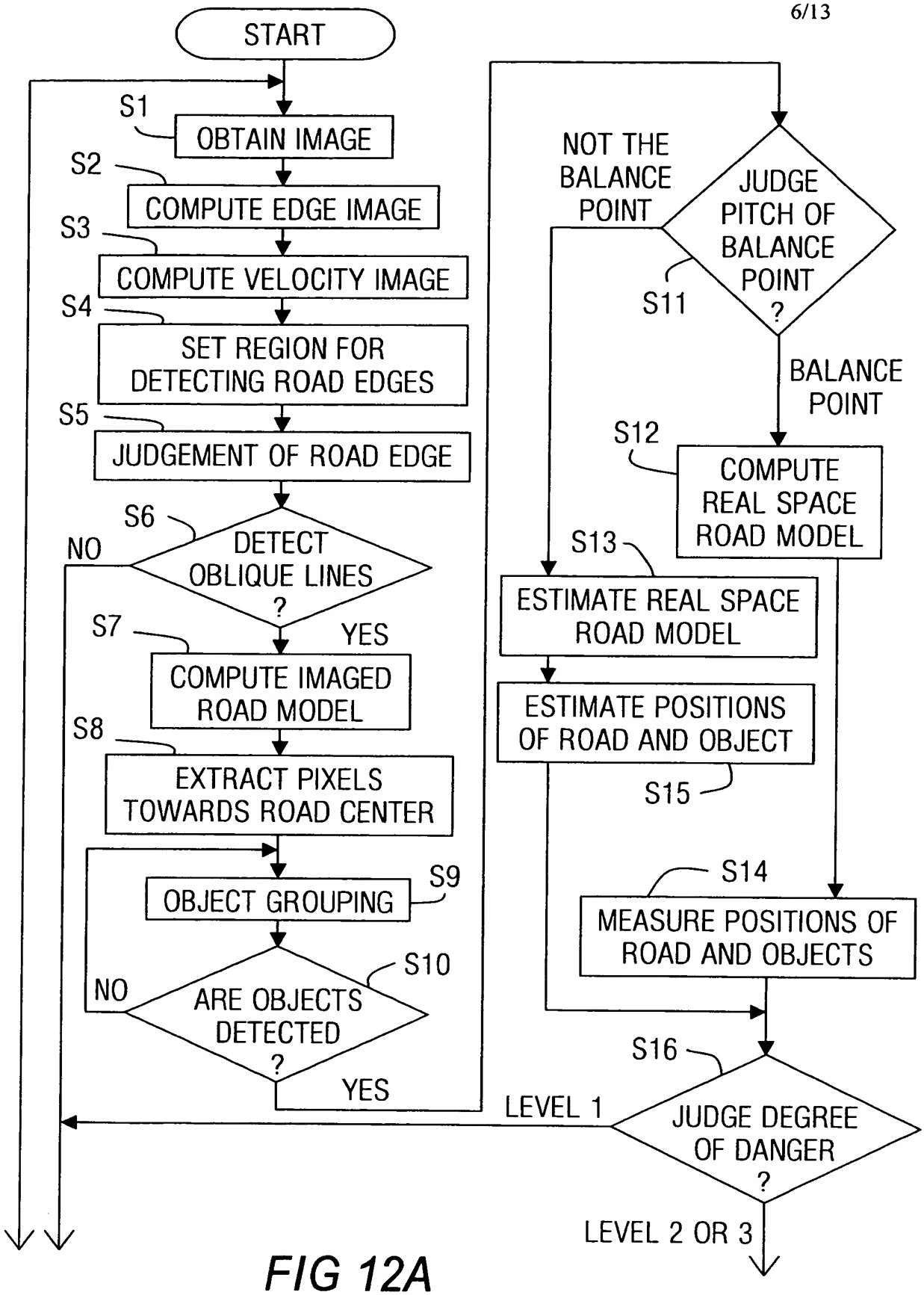

START
S1
OBTAIN IMAGE
S2
COMPUTE EDGE IMAGE
S3
COMPUTE VELOCITY IMAGE
S4
SET REGION FOR DETECTING ROAD EDGES
S5
JUDGEMENT OF ROAD EDGE
S6
DETECT OBLIQUE LINES ?
NO
YES
S7
COMPUTE IMAGED ROAD MODEL
S8
EXTRACT PIXELS TOWARDS ROAD CENTER
S9
OBJECT GROUPING
S10
ARE OBJECTS DETECTED ?
NO
YES
NOT THE BALANCE POINT
JUDGE PITCH OF BALANCE POINT ?
S11
BALANCE POINT
S12
COMPUTE REAL SPACE ROAD MODEL
S13
ESTIMATE REAL SPACE ROAD MODEL
ESTIMATE POSITIONS OF ROAD AND OBJECT
S15
S14
MEASURE POSITIONS OF ROAD AND OBJECTS
S16
JUDGE DEGREE OF DANGER ?
LEVEL 1
LEVEL 2 OR 3

FIG 12A

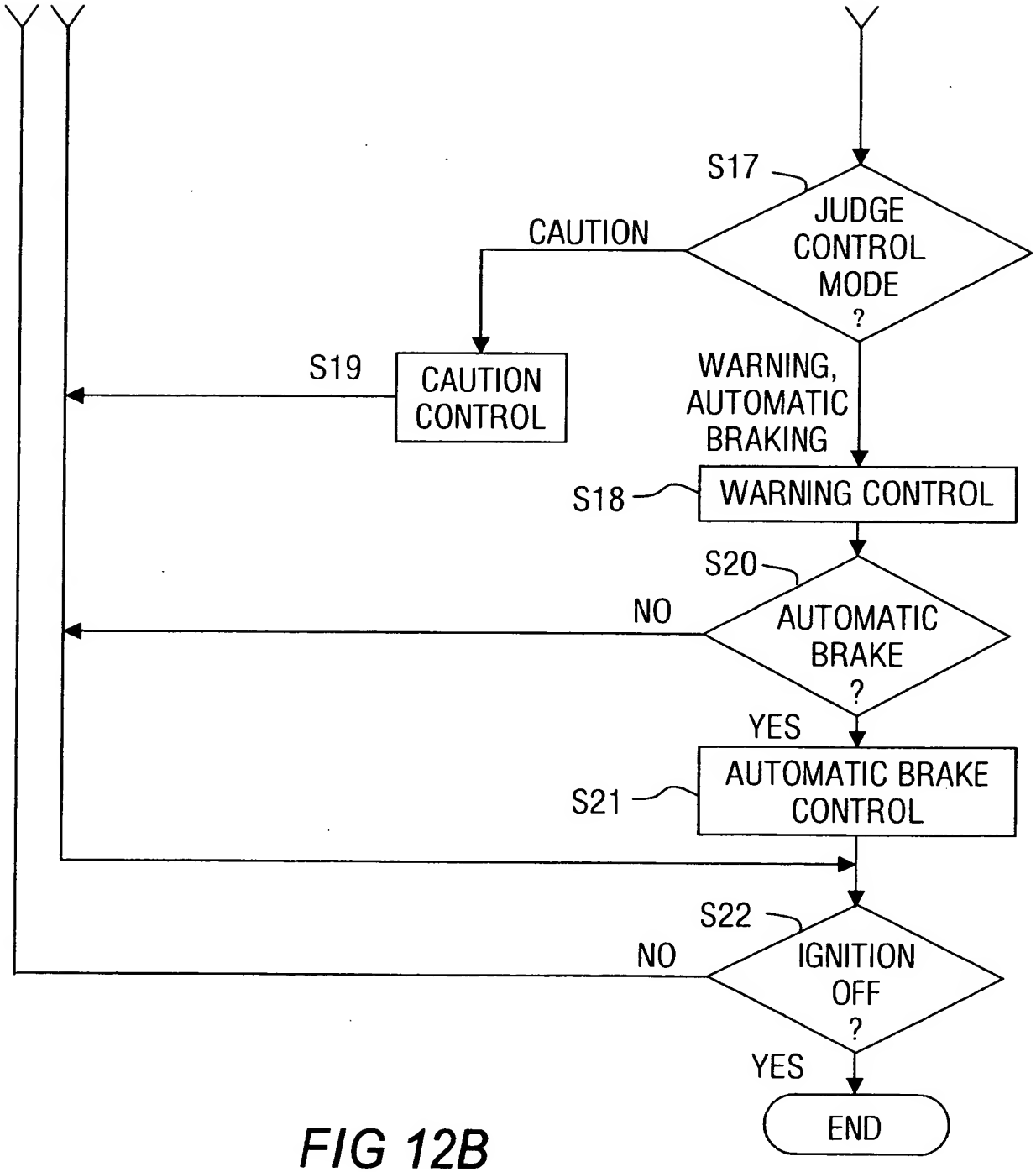

S17
JUDGE CONTROL MODE ?
CAUTION
S19
CAUTION CONTROL
WARNING, AUTOMATIC BRAKING
S18
WARNING CONTROL
S20
AUTOMATIC BRAKE ?
NO
YES
S21
AUTOMATIC BRAKE CONTROL
S22
IGNITION OFF ?
NO
YES
END

FIG 12B

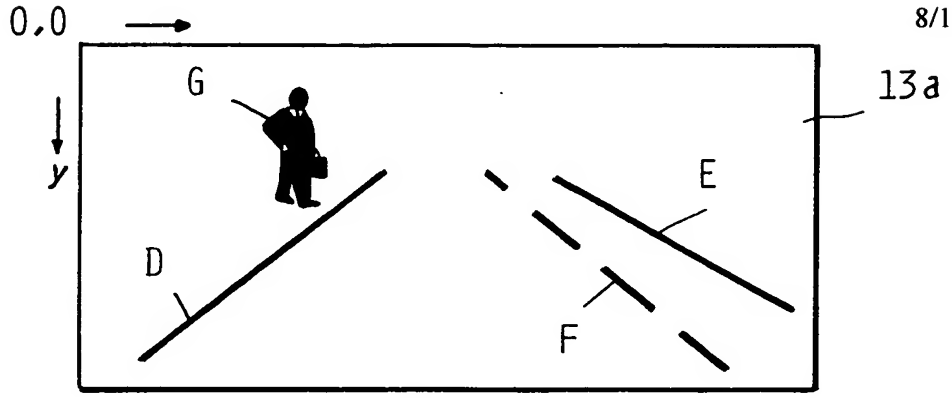


FIG. 13

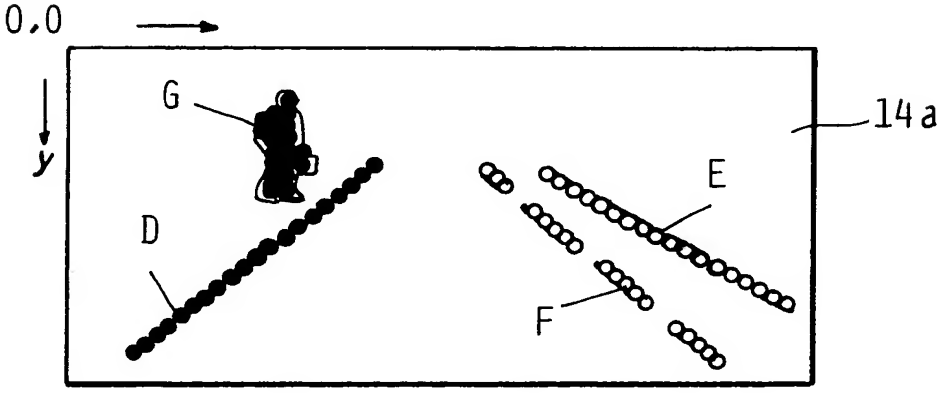


FIG. 14

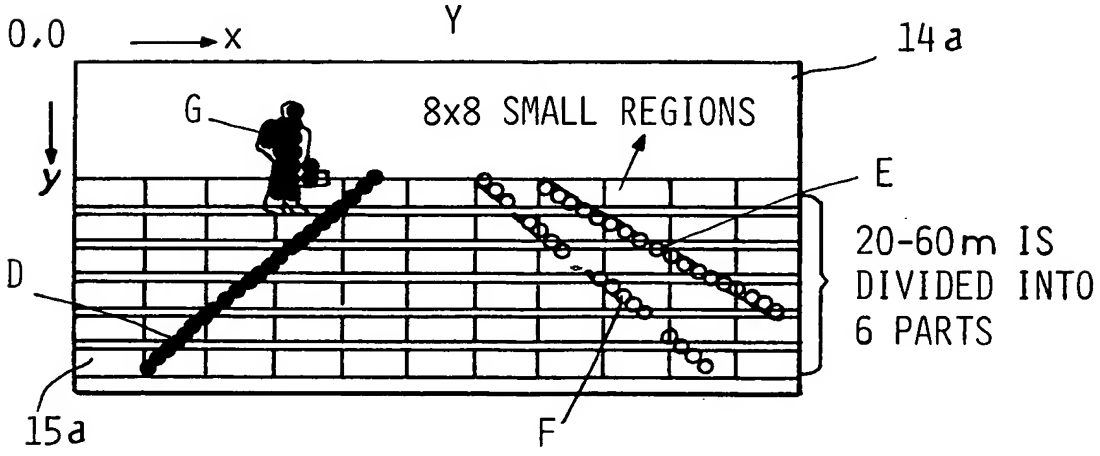


FIG. 15

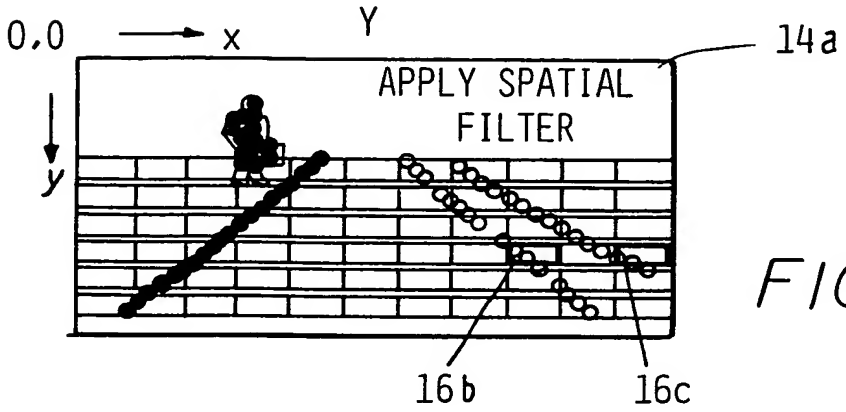
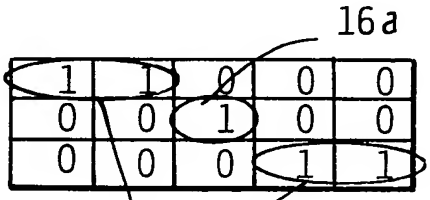


FIG. 16A



IDENTIFIED AS A DOT CANDIDATE WHEN VELOCITY IS DETECTED ABOVE AND/OR BELOW THE DOT IN THE OBLIQUE DIRECTION

IF A LINE SECTION FORMED BY THREE OR MORE DOT CANDIDATES SATISFIES THE SLOPE CONDITION, IT IS DETECTED AS AN OBLIQUE LINE CANDIDATE

FIG. 16B

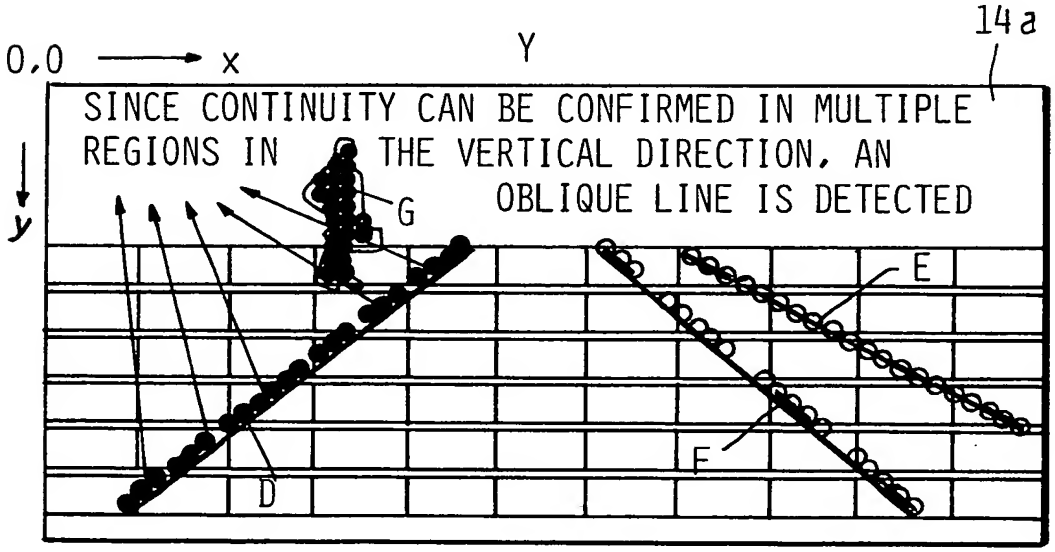


FIG. 17

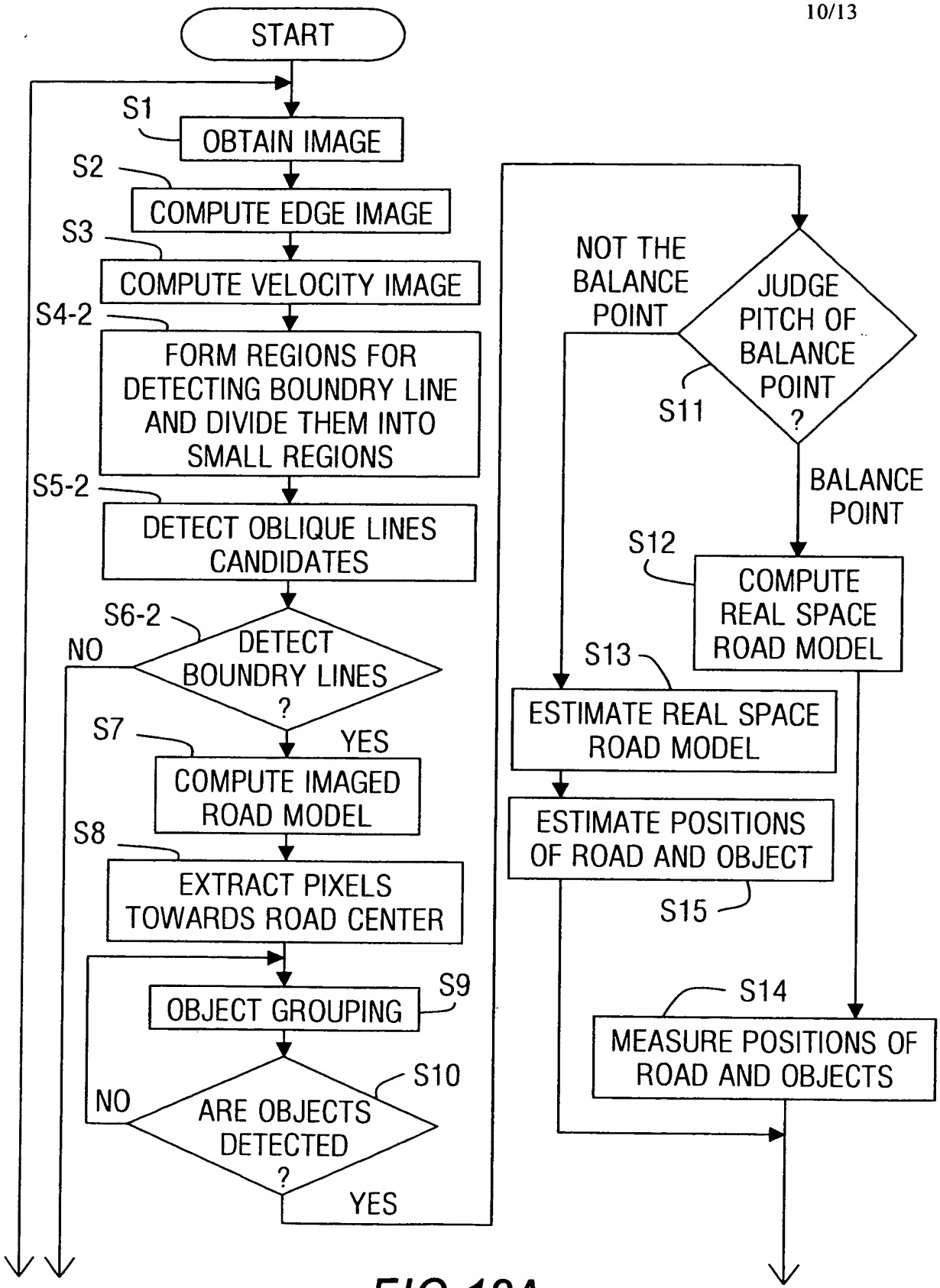

START
S1
OBTAIN IMAGE
S2
COMPUTE EDGE IMAGE
S3
COMPUTE VELOCITY IMAGE
S4-2
FORM REGIONS FOR DETECTING BOUNDRY LINE AND DIVIDE THEM INTO SMALL REGIONS
S5-2
DETECT OBLIQUE LINES CANDIDATES
S6-2
DETECT BOUNDRY LINES ?
NO
YES
S7
COMPUTE IMAGED ROAD MODEL
S8
EXTRACT PIXELS TOWARDS ROAD CENTER
S9
OBJECT GROUPING
S10
ARE OBJECTS DETECTED ?
NO
YES
JUDGE PITCH OF BALANCE POINT ?
S11
NOT THE BALANCE POINT
BALANCE POINT
S12
COMPUTE REAL SPACE ROAD MODEL
S13
ESTIMATE REAL SPACE ROAD MODEL
ESTIMATE POSITIONS OF ROAD AND OBJECT
S15
S14
MEASURE POSITIONS OF ROAD AND OBJECTS

FIG 18A

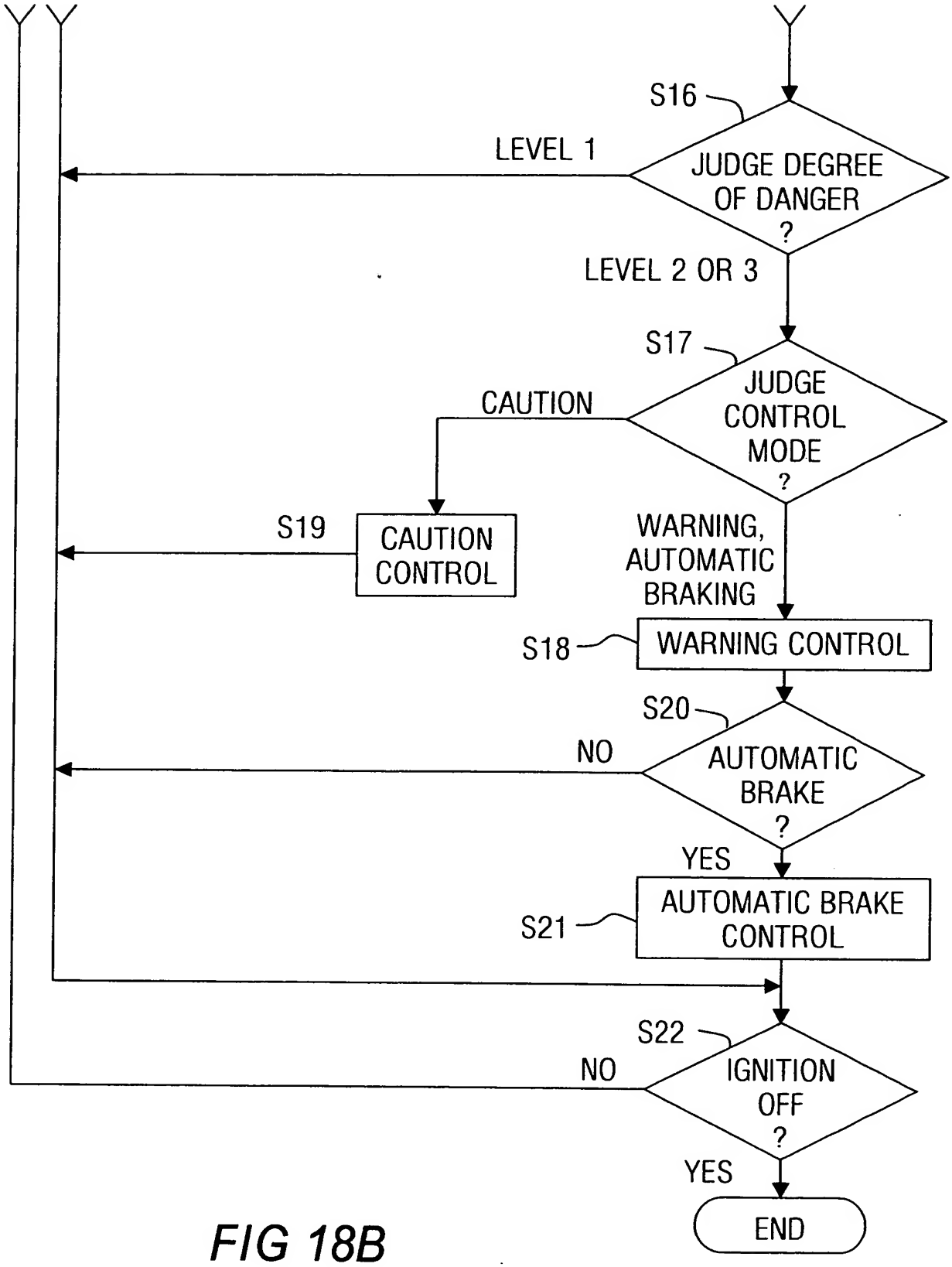

S16
JUDGE DEGREE OF DANGER ?
LEVEL 1
LEVEL 2 OR 3
S17
JUDGE CONTROL MODE ?
CAUTION
S19
CAUTION CONTROL
WARNING, AUTOMATIC BRAKING
S18
WARNING CONTROL
S20
AUTOMATIC BRAKE ?
NO
YES
S21
AUTOMATIC BRAKE CONTROL
S22
IGNITION OFF ?
NO
YES
END

FIG 18B

FIG. 19

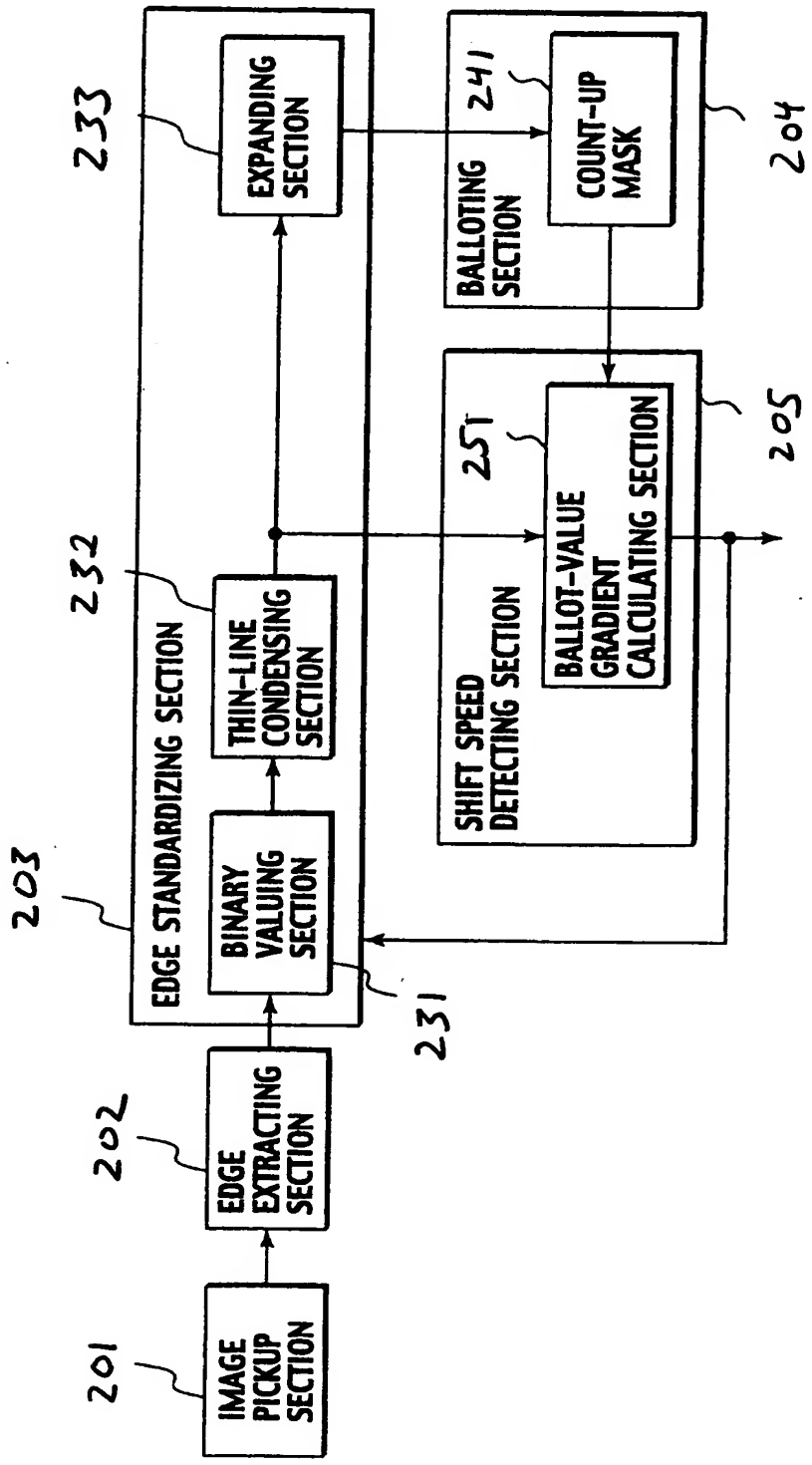


IMAGE PICKUP SECTION
201
EDGE EXTRACTING SECTION
202
EDGE STANDARDIZING SECTION
203
BINARY VALUING SECTION
231
THIN-LINE CONDENSING SECTION
232
EXPANDING SECTION
233
SHIFT SPEED DETECTING SECTION
251
BALLOT-VALUE GRADIENT CALCULATING SECTION
205
BALLOTING SECTION
241
COUNT-UP MASK
204

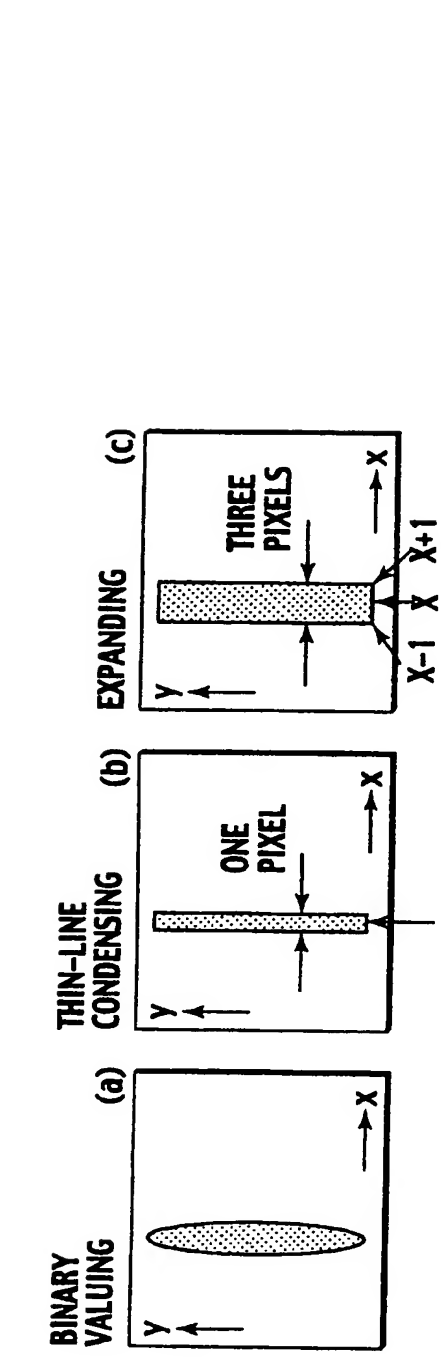

(a)
BINARY VALUING
(b)
THIN-LINE CONDENSING
ONE PIXEL
(c)
EXPANDING
THREE PIXELS
X-1
X
X+1
x
y

FIG. 20

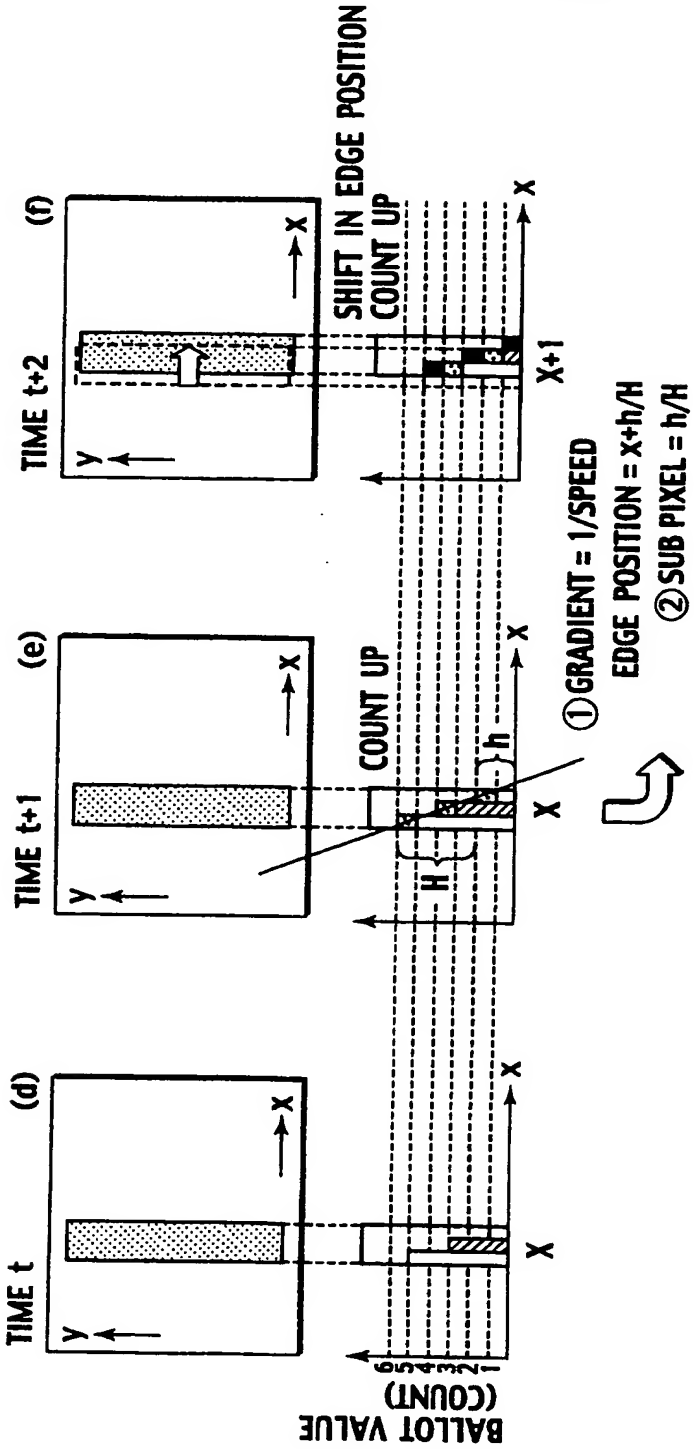

(d)
TIME t
(e)
TIME t+1
COUNT UP
(f)
TIME t+2
SHIFT IN EDGE POSITION
COUNT UP
①GRADIENT = 1/SPEED
EDGE POSITION = x+h/H
②SUB PIXEL = h/H
h
H
X
X+1
x
y
BALLOT VALUE (COUNT)
6
5
4
3
2
1

FIG. 21